Guide to Optimizing Commercial Kitchen Ventilation

The Problem

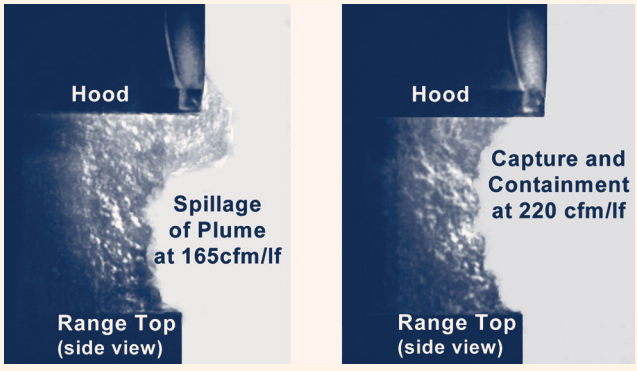
Kitchen ventilation systems represent one of the largest uses of energy in a commercial food service facility, accounting for up to 75 percent of the HVAC load. This load itself accounts for about 30 percent of a restaurant's total energy consumption. Yet many kitchen ventilation systems are poorly designed, creating an uncomfortable work environment and leading to the use of more energy than necessary. Large amounts of outside makeup air are typically required, but no consistent guidelines have been available to help designers determine the best ways of introducing that air efficiently and without compromising the ventilation's effectiveness (see **Figure 1**).

The Solution

Based on the results of tests conducted on a mock-up of a commercial kitchen, a group of researchers, with Pacific Gas and Electric's Food Service Technology Center, has created a comprehensive design guide for commercial kitchen ventilation systems. Called "Improving Commercial Kitchen Ventilation System Performance: Optimizing Makeup Air," the guide presents strategies for minimizing the impact that the introduction of makeup air will have on hood performance and energy consumption. The guide is aimed at kitchen designers, mechanical engineers, food service operators, property managers, and maintenance personnel.

Figure 1: Visualization of exhaust hood performance

Cooking creates thermal and effluent plumes that must be drawn up into the exhaust hood; otherwise, the plumes spill into the kitchen. That spill-over subjects the room's occupants to heat, products of natural gas combustion (carbon dioxide, water, and, potentially, carbon monoxide), and products from the cooking process, such as grease vapor and particles, odors, water vapor, and miscellaneous hydrocarbon gases.



Note: cfm/lf = cubic feet per minute per linear foot.

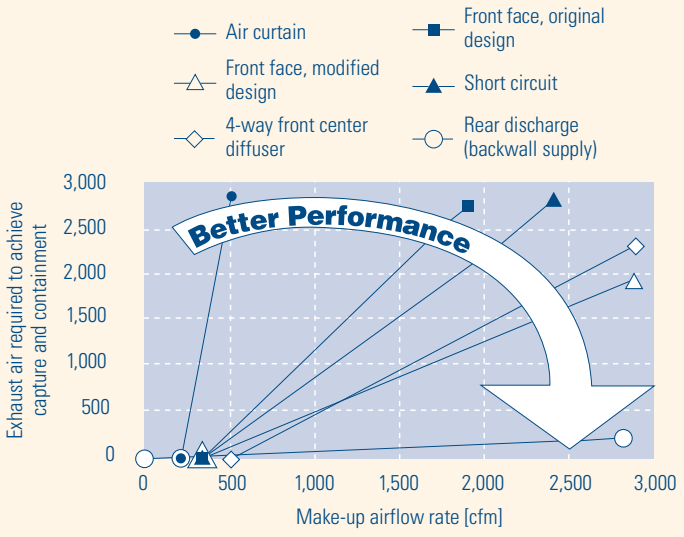
Features and Benefits

To aid in the creation of efficient and effective kitchen ventilation schemes, the guide offers:

- An introduction to the fundamentals of kitchen exhaust systems and types of exhaust hoods.
- Descriptions and diagrams of five strategies for makeup air introduction.
- Suggestions for the best types of strategies for introducing makeup air. These strategies are based on performance testing (see **Figure 2**) and flow visualization images that show the strategy's impact on the ability of a kitchen exhaust hood to capture and contain a thermal plume.

Figure 2: Comparing makeup air strategies

The arrow points to the best makeup air strategy—the one that least disturbs the exhaust system's ability to capture and contain effluents. Most of the strategies investigated required significant increases in the exhaust rate to overcome the negative impact of introducing makeup air. The best results were achieved with rear discharge, in which the makeup air is discharged downward starting from a low position on the wall behind the cooking appliances.



Note: cfm = cubic feet per minute.

- Descriptions of alternative methods for introducing makeup air. For example, depending on the layout of the space, it may be possible to pull makeup air from the dining room into the kitchen. That air must be supplied by the HVAC system to meet code requirements for ventilating the dining room. Using it in the kitchen as well reduces the total amount of makeup air required, thereby decreasing the fan power needed and the amount of air that must be conditioned.
- A case study with diagrams that illustrates the improvements possible in kitchen ventilation. The case study also presents estimated annual energy savings resulting from the suggested improvements.

A commercial kitchen ventilation system that is designed using the guide is not only likely to improve safety and comfort—it will also save a good deal of energy. If you assume an across-the-board reduction in exhaust, and replacement air fan energy use of 15 percent, applying these recommendations in the state of California would cut electric energy consumption by about 69 gigawatt-hours and reduce demand by about 14 megawatts (see page 8 of PIER Report # P500-03-007F, referenced under "For More Information" below). These are conservative estimates, as they do not include reductions in the cooling and heating energy that result from decreasing the quantity of makeup air.

Applications

The information presented is applicable to new construction and retrofit construction of commercial and institutional kitchens.

California Codes and Standards

Title 24 does not address kitchen ventilation systems; however, this research may be used to develop future code revisions.

What's Next

The Food Service Technology Center is currently conducting workshops about designing kitchen ventilation systems based on the design guide. These workshops are being held in conjunction with Southern California Gas Co. as well as Pacific Gas and Electric Co.'s Pacific Energy Center.

Collaborators

The organizations involved in this project include Pacific Gas and Electric Co., Architectural Energy Corp., and Fisher-Nickel Inc.

For More Information

Reports documenting this project and providing more details may be downloaded from the web at www.energy.ca.gov/pier/final_project_reports/500-03-007f.html, and the design guide "Optimizing Makeup Air" may be downloaded from www.foodservicetechnologycenter.com/ckv/designguide. Also available on this site is a companion guide called "Selecting and Sizing Exhaust Hoods," which was created with funding by California utility customers and administered by Southern California Edison under the auspices of the California Public Utilities Commission.

To view Technical Briefs on other topics, visit www.esource.com/public/products/cec_form.asp.

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About PIER

This project was conducted by the California Energy Commission's Public Interest Energy Research (PIER) program. PIER supports public-interest energy research and development that helps improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

Arnold Schwarzenegger, *Governor*

For more information see www.energy.ca.gov/pier

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